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ABSTRACT

One of three publications of the Research on Equitable Access to Technology project, this paper provides a literature review of the issues surrounding the provision of equitable access to computers for all children. Both the extent and types of inequities are explored, including hardware and software issues, and language and sex inequities. The effectiveness of computer instruction for underutilizing students is detailed, and five instructional variables that need to be emphasized in the case of low socio-economic, low-achieving, and minority students are considered: (1) cognitive styles; (2) expectations; (3) reinforcement; (4) academic learning time; and (5) classroom organization and groups. The importance of peer teaching is stressed, particularly because of the lack of available trained teachers and limited opportunities for computer training in disadvantaged schools. The report concludes with a discussion of some of the implementation issues that must be considered when setting up and maintaining a computer training program which addresses equity issues. (84 references) (EW)

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COMPUTERS FOR ALL CHILDREN:

A LITERATURE REVIEW OF EQUITY ISSUES IN COMPUTER UTILIZATION

Janet Crist-Whitzel

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November 1985

FAR WEST LABORATORY
FOR EDUCATIONAL RESEARCH AND DEVELOPMENT

COMPUTERS FOR ALL CHILDREN:

A LITERATURE REVIEW OF EQUITY ISSUES

IN COMPUTER UTILIZATION

Janet Crist-Whitzel

CREATE
Center for Research on Equitable
Access to Technology in Education

Far West Laboratory
for Educational Research and Development
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November 1985

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A Literature Review of Equity Issues in Computer Utilization

Perspectives on Technology and Equity

The issue of equitable access to computers in education is critical to the educational community and has far-reaching implications for the nation as a whole in preparing the future workforce.

Some estimates say that by 1990 about 8 out of 10 jobs will require some knowledge of computers either directly or tangentially (Frank, 1983; Fisher & Finkel, 1983). However, Stanford researchers Levin and Rumberger argue that even though high-tech jobs will double by 1990, such jobs will still be far outpaced by such low-skill jobs as janitors, nurses' aides, sales clerks, cashiers, waiters and waitresses, and fast-food workers (Siegel, 1983). Even so, they state that with the existing and continuing spread of computers at work and in homes, students do need to learn about computers to help them deal with an increasingly technologically-oriented society, and schools are the "democratizing" institutions that can provide an exposure to children without computer opportunities at home.

Even though all jobs are not going to require sophisticated computer expertise, we must ask ourselves which of today's children will be able to assume those jobs which do require such a background. It has been said that you don't need to be computer literate to work at McDonald's--but the irony of that is the realization that those who do not have "computer literacy" are going to end up as the fast-food workers of the country and won't have an opportunity for the higher-level jobs which consequently will be reserved for those who do have high-tech preparation.

In fact, numerous writers have warned of the dangers of widening the already-existing technology gap between the haves and have-nots if current trends continue (Podemski, et al., 1983; NSBA, 1983; Karoff, 1984; Emmett, 1983; Hechinger, 1983; Puetz, 1984; TERC, 1983; Mace, 1983). The current trend shows that such

a gap is indeed apparently widening when statistics for 1979 and 1982 are compared (Anderson et al., 1984). In the next generation the majority of the workforce will be women and minorities (Karoff, 1984), and for the welfare of the nation, it has been argued that they must be included among the technologically-trained workers. Not including the currently underutilizing groups of students (e.g., disdavantaged, minorities, and females) in training for computer literacy might relegate them to the "permanent underclass" of the future (Karoff, 1984; Castillo, 1984; Euchner, 1983).

The Extent (Quantity) of Inequities

Several recent studies confirm the extent of inequities in the amount of computer opportunities or access to school microcomputers. A Market Data Retrieval Study showed that in October 1982 almost 2-1/2 times as many of the country's wealthiest districts had microcomputers compared to the poorest districts (Podemski et al., 1983). The National Assessment of Educational Progress Study at the University of Minnesota presented data showing that 70% of the wealthiest schools, compared to only 40% of the poorest schools, have micros and that, when comparing the 12,000 wealthiest with the 12,000 poorest districts in the country, the affluent students are four times as likely to have computer access (Karoff, 1984; Anderson et al., 1984).

The National School Boards Assocation in its ComputerWise newsletter summarized the available evidence by saying that two-thirds to three-fourths of the most affluent schools have at least one microcomputer, whereas about 60% of the poorest schools do not have any (NSBA, 1983).

The widely publicized Johns Hopkins study of microcomputer use in schools showed that as elementary schools acquire more computers, they do provide access to a greater number of their students. However, as secondary schools gain more computers, they provide more access time to about the same number of students

as before (Becker, 1983 a, b).

The Johns Hopkins survey confirmed that low-income (elementary) schools have higher student-to-computer ratios than high-income schools. One-quarter of high-SES-school students use a computer per week, as opposed to only half that percentage of students in low-income schools. Furthermore, among those low-income schools, the predominantly minority schools had higher student-to-computer ratios than white majority schools, indicating that racial minority students have an added disadvantage over and above their inequitable computer access due to low economic status (Education Daily, 10/31/83). In addition, Becker (1983c) reported that low-SES predominantly minority schools provide half as much computer time during the week as predominantly white low-SES elementary schools.

A 1982 NEA survey of teachers found that a far higher percentage of teachers in suburban areas (41%) and small towns (28%) used computers in instruction than teachers in rural (16%) or urban areas (15%). Reporting of teachers' attitudes showed that 41% of the 1200 teachers responding (34% of non-computer-using teachers, and even 12% of teacher users!) indicated they did not believe there should be a school policy calling for opportunity for all students to learn to use computers in the classroom (Norman, 1983).

There is additional evidence of computer inequities for disadvantaged and minority students beyond the schools. A survey of 23 summer computer camps in 1982 by Hess and Miura (1983) found that 98% of students enrolled in these camps were from upper-and middle-class families, with only 2% from minority groups (mostly Asians).

The Type (Quality) of Inequities

Study after study likewise has shown the existence of serious disparities in the type of computer use as well as the amount of use by students differing in social class and ability. These studies report that more affluent and higher-

achieving students learn programming and advanced computer applications while disadvantaged and low-achieving students (when they do have access) use computers mainly for drill and practice, often for remedial instruction (Arias, 1984; Becker, 1983 a, b; Brookover & Lezotte, 1981; Cardenas, 1983; NSBA, 1983; Karoff, 1984).

As Karoff states,

> "most disturbing are recent data which show that even where access is available to underprivileged students, the quality and sophistication of computer-assisted instruction is frequently found lacking. Poor kids do passive drill and practice exercises... Rich kids learn how to program" (p. 52).

Or, as Watt so aptly puts it, "...affluent students are thus learning to tell the computer what to do, while the less affluent students are learning to do what the computer tells them" (quoted by Cardenas, 1983, p. 3).

Teacher attitudes as well as local and federal resources play a role in fostering such a disparity in quality of computer opportunities. Many teachers feel that learning of computer skills should be targeted at high-achieving, gifted students, while others feel that low-achieving students should concentrate on building their basic skills through drill and practice uses (Podemski et al., 1983). An additional contributor to this disparity is the requirement for schools purchasing computer equipment with certain federal funds to use them for basic skills with their disadvantaged students (Castillo, 1984).

In a recent NEA survey, 66% of the teachers responding had some (30%) or considerable (36%) interest in the use of computers for enrichment with high ability students; 53% had some (26%) or considerable (27%) interest in computer use for remedial drill and practice for low ability students (Norman, 1983). Apparently this dichotomy in perceived appropriate computer uses is relatively firmly established among the majority of teachers in this country.

Hardware and Software Issues

As one program director with whom we talked succinctly put it, "As long as there are ten micros and four hundred students in a school there will be an access problem." Becker's (1984) analysis of microcomputer use and location in the school concluded that the location of the computer has an important effect on who gets to use it, the level of use, and the kind of use. Classroom use tends to be equitable but has negative use consequences. Laboratory use tends to have positive consequences except for equity. Differences at elementary and secondary levels also turn up.

Dispensing microcomputers among several locations at any one time appears to have only negative consequences for elementary schools, but has the benefit in secondary schools of increasing micro access to larger groups and for a broader range of activities. Of course, there is ample evidence that the rush to provide some computing experience to students has resulted in concepts of computer literacy and uses of software which do not promote students' abilities to make use of the computers for dealing with problems of interest to them. Tinker (1984) suggests that literacy programs based on the use of software tools would appeal to a broader range of students than would programming classes. He suggests that students "should be able to craft general-purpose tools into special tools" for the purposes that will motivate and involve them.

Thus students whose use of computers does not include programming or expensive business applications packages are less likely to have quality instructional activities with the computer. Walker (1984) points to a dilemma in utilization of software:

> ...(The variety of demand for software) means that the market for any single piece of software...will be smaller than the market for more generally workable programs. The market for software in those subjects is too limited to justify an investment in producing it. And so long as the selection

> of software is limited, many schools and teachers will be reluctant to use computers in their teaching (of) mainline academic subjects. (p. 4)

Thus a complex policy question exists with regard to underserved students -- when they do get a chance to use computers, their situations of use are known to be less than desirable, yet research shows that low-SES students tend to gain academically from such use.

Sex and Language Inequities

The pattern of inequities in both quantity and quality of computer access discussed above has also been documented for females and for students who are limited in English language proficiency, as well as minority and disadvantaged students (Hess & Miura, 1983; Arias, 1984; Cardenas, 1983; Campbell, 1983). Considerable attention has focused particularly on the question of sex equity in computer opportunities, but many of the factors affecting such inequity generally apply to limited English proficient (LEP) students as well, especially Hispanics (cf. Arias, 1984; Cardenas, 1983). Other LES or ESL minority groups including those from the Pacific Islands (such as Samoans--who comprised one of our classes) are also subject to the compounded inequities due to both minority ethnic and language status.

Males are more aggressive than females in seeking computer opportunities (Marrapodi, 1983; Campbell, 1983; Hamilton, 1984; Kiesler et al., 1983) and are more likely to learn programming (especially at the level of more advanced programming languages) while females are more likely to learn to use computers for such purposes as word processing (Fisher, 1984; Van Nuys, 1983). Some experience has shown that computer programming instruction using LOGO or oriented toward art has been more successful in attracting females (Fisher, 1984). Linn (1984) reports that male and female students clearly differ on their orientation toward computer learning environments. Males had more realistic expectations, tended to go beyond the information given, and sought help more often than females.

Females tended to blame failure on themselves more than males did.

Parents are more likely to support and encourage their sons' than their daughters' pursual of computer interests, whether it be purchasing computers for them (Van Nuys, 1983; The Stanford Educator, 1984; Castillo, 1984; Fisher, 1984) or sending them to computer camps (Hess & Miura, 1983). Software for both games and education (not to mention video arcade games which engender computer interest among many males, especially) are heavily male-oriented (The Stanford Educator, 1984; Kiesler et al., 1983; Marrapodi, 1983; Van Nuys, 1983; Education Daily 1/23/84). More male than female computerist role models abound in the media as well as in schools (Marrapodi, 1983; Van Nuys, 1983).

The emphasis on mathematics in programming courses, as well as the widespread inclusion of computer courses in mathematics (or science) departments and the requirement of certain math courses such as algebra as prequisites to programming courses all serve to restrict the participation of females and many minority students in higher level computer classes such as programming (Kiesler et. al., 1983; Van Nuys, 1983; Arias, 1984; Fisher, 1984). The more advanced or costly the levle of involvement, the more the gap between boys and girls increases (Kiesler, et al., 1983; Lepper et al., 1984).

Because of all these factors, as well as peer culture itself (Van Nuys, 1983; Kiesler et al., 1983), serious computer-using students tend to be overwhelmingly white, male, and from high-SES families.

Effectiveness of Computer Instruction for Underutilizing Students

There is growing evidence that computer-based instruction can be academically beneficial to precisely the types of students who suffer the most from unequal access (e.g., Saracho, 1982). In a meta-analysis of 51 separate studies of the effects of computer-based teaching in grades 6-12, Kulik, Banger, & Williams (1983) found that instruction via computer raised performance of students in

general as well as decreased the amount of learning time. Of particular note to the present discussion was the finding that computer-based learning seemed especially effective for disadvantaged students. In those studies which assessed effects on student attitudes, positive effects of CBI were found as well for attitudes toward subject matter, computers, and instruction.

Even greater achievement effects than reported by Kulik et al. (1983) were shown in ETS research in Los Angeles for younger elementary children (Bracey, 1982; Connell, 1983). Effectiveness of CAI or CBI on student performance and/or attitudes (including enhanced feelings toward self and sense of personal control) has been documented in other studies reported by Ryba & Chapman (1983).

In an overview of CAI research, Bracey (1982) reports that in "the area of affective/motivational outcomes of CAI, the news is almost all good" (p. 54). Teachers have reported that some of the major benefits of computer instruction are improved motivation and attitudes (Becker, 1983; EL News, 1983; Norman, 1983).

Researchers and teachers have also indicated the success of microcomputers in enhancing collaboration and cooperative learning among students (Becker, 1983; Resnick, 1984; Ryba & Chapman, 1983). Bracey (1982) even reports seeing "more collaborative, cooperative problem solving among kids who are doing programming activities together than anywhere else in schools" (p.54).

Other research has documented that various forms of cooperative learning and peer tutoring have been effective in enhancing academic performance among black and Hispanic students and for reducing social distance, improving interracial and school-related attitudes, and fostering equal status interactions among students of different racial and ethnic minorities (e.g., Slavin, 1978; 1980; Aronson et al, 1978; Crist-Whitzel, 1980).

Perspectives on Effective Instruction for Minorities and Low-SES Students

Coupled with the evidence already documented that certain groups of students are underserved in terms of access to computers, a review of effective teaching for low-SES, low-achieving, and minority students helps to determine possibile parameters for effective computer education programs for the underserved students. Some of the instructional variables that seem important to take into account for these groups of students include: cognitive or learning) styles, expectations, reinforcement, academic learning time, and classroom organization or grouping.

Cognitive Styles

Socionomically disadvantaged students and minorities have been shown to have learning styles that are more "field-dependent" and that cause them to be sensitive to social cues; thus, they prefer learning in more social settings and are sensitive to social feedback (Ramirez & Casteneda, 1974; Witkin, Moore, Geeodenough, & Cox, 1977; Deutsch, 1967).

Teacher Expectations

Many studies have shown that teachers hold differential expectations for students and that these expectations related to student performance (Baker & Crist, 1971; Brophy & Good, 1974; Dusek, 1975; Good & Brophy, 1977). Expectations are often based on students' physical appearance, conduct, achievement, sex, race, and socionomic status (Baker & Crist, 1971; Palardy, 1969; Rist, 1970). Because of low expectations, teachers may give low SES and minority children less time to respond to questions, give them more criticism and less praise, pay less attention to them, interact less with them, and demand less of them (Rist, 1970; Good & Brophy, 1977). Because many of these students tend to be field-independent, such lack of supportive feedback and interaction

can make them vulnerable to negative effects. It has been pointed out that the computer does not treat individuals differentially and thus does not exhibit negative expectations.

Intrinsic and Extrinsic Reinforcement

More field-sensitive persons are influenced by social reinforcement and feedback, especially positive feedback and respond to structured learning material (Witkin, et al., 1977). Although not human, the computer often takes on human qualities to the user. When the computer responds to a student, it often serves a reinforcing function.

Academic Learning Time

Research on academic learning time has shown that allocated time, student engagement, and student success rate is related to student achievement gains (Fisher, Marliave, & Filby, 1979; Powell, 1979; Berliner, 1979). Stallings (1980) has shown also that interactive on-task variables such as praise and support, supportive corrective feedback, and discussion/review ralate to achievement gains, especially for low prior achieving students. This information supports that already cited.

Classroom Organization (Grouping) for Instruction

A great deal of research, and many reviews of research, has studied the effectiveness of cooperative, competitive, and individualsistic classroom goal structures on student attitude (including inter-ethnic/-racial attitudes) and achievement. Overall, cooperative methods, either with or without intergroup competition, appear to be more effective for students in general, and field-dependent students in particular, with their learning styles attuned to social aspects (Aronson, Blaney, Stephan, Sikes, & Snapp, 1978; Slavin, 1980b, 1978, 1977b; Johnson, 1981; Johnson, Maruyama, Johnson, Nelson, & Skon, 1981, Sharan, 1980).

It appears that, although competitive and individualistic classroom goal structures are the most commonly used reward structures in the typical classroom (Michaels, 1977), the above-cited research supports the use of cooperative learning activities. Such activities seem to be especially useful and appropriate for minority and low-SES students (e.g. black and Chicano children -- see Aronson et al., 1978) because of their effectiveness in producing positive intergroup attitudes and promoting success for low achievers (Slavin, 1980a, b).

Implications for Effective Computer Education Programs

Currently there is a widespread recognition that many adults experience more anxiety than students toward learning to use the computer. Although many teachers enthusiastically embrace the task of learning programming skills, it is widely recognized that students are quickly outpacing teachers and other adults in mastering computer skills (Assembly Office of Research, 1982; Frank, 1983; Time, May 3, 1982). The critical national shortage of science and mathematics teachers (Mace, 1983) compounds the problem of providing the computer literacy instruction to all students which has become a nationally proclaimed goal (National Commission on Excellence in Education, 1983; Lesgold & Reif, 1983; Gibbons, 1983).

One solution to this double problem of lack of available trained teachers and less opportunity for computer training in disadvantaged schools is to have computer-literate pupils teach computer literacy, including computer programming to other students.

Advantages to such peer computer instruction include: (1) peer tutoring and other cooperative learning methods are effective learning modes in general for both tutors and tutees (Cohen et al, 1982; Good & Brophy, 1973), effective particularly for black and Hispanic students, and foster social integration among students of different races/ethnicities (Slavin, 1978; 1980; Aronson et al, 1978); (2) students are proving to be rapid and adaptable computer learners; (3) student trainers gain important skills of designing instruction, training others, and evaluating the implementation process; (4) trainees gain basic computer literacy and help researchers and trainers identify a training design with high potential for utilization and effectiveness for underutilizers; (5) the expertise of experienced student trainers can become a resource for transferring the teaching model to other groups of students. Also, the peer instructional model requires

minimal staff to guide and monitor training; once implemented in a school, can be self-regenerating and cost-effective; and would not require extensive teacher training efforts.

One example of an effective peer teaching program is that used at San Francisco's Lowell High School for high achieving students. This model was modified by the Center for Equitable Access to Technology in Education at Far West Laboratory where six Lowell computer-literate students developed a peer teaching demonstration project to reach disadvantaged students with little access to computers (Crist-Whitzel, Dasho & Beckum, , 1984). A slightly different but effective tutoring model is the Computer Tutor Program based in Palo Alto (Stevens, 1982). The general model seemed to hold promise for academically and/or culturally disadvantaged students with less access to computer instruction because of the research on both cooperative learning and effects of computer-based instruction.

Another important dimension of academic success is parental support for learning. The Houston Independent School District has gained national attention with its large-scale effort to solve the access issue (Reingold, 1985). The Houston programs include Chapter 1 parent computer training, home lending libraries for software and discounts on hardware, four hundred ESL learning stations with voice synthesis, and matching funds for PTAs to get parents to raise money for computers in the schools.

The EPIE 4E Community-Classroom Computer Connection program combines aspects of student and parent involvement. Skilled students are developing the training materials and organizing volunteers, low-income parents and their children will receive training together, and after school and home access to computers will be available.

Implementation Issues

Although there is definitely a need for closer study of methods for maximizing the amount of conceptual understanding about programming, programming tricks and shortcuts, and transfer of literacy and introductory programming such as LOGO experiences into applications skills. Equal access issues must be tied to meaningful access and adequate support. Because parent involvement programs, peer-teaching programs and programs which utillize well managed cooperative learning principles are rare, implementation quality becomes an important dimension for assessing the impact of computer training for underserved students.

This review, having examined many of the research findings about teaching low achievers, cannot exhaust the total universe of concerns and issues surrounding the quest for effective educational delivery. In this concluding section we will briefly touch upon some of the implementation factors which must be taken into account in setting up and maintaining a computer training program which addresses equity.

School Staff Involvement and Commitment. At each step--from recruiting students to making logistical and scheduling arrangements for equipment, determining the course content for school credit, etc--teachers and administrators must be responsible for deciding how such a program will operate within the context of the rest of the school. Are underserved students to be encouraged to register for existing computer training offerings and given special assistance? If specially designed programs are put into place will teachers receive training for tailoring existing materials and curricular outlines, or will new ones be developed or sought? Is there a problem with teacher access to computers--e.g., are the special programs able to use the equipment and expertise available in the school/district or do they operate in isolation?

Matching the Needs of Students

Another important backround feature of an effective computer training program is the extent to which the program was designed to address student needs which were not met by existing course offerings, or which capitalizes on student interests to provide motivation for academic effort. For example one high school in San Francisco is offering students who have been caught painting graffiti the opportunity to use computer graphics to do their artwork and possibly to train other students to use the software.

Providing Qualified Trainers

Because of the lack of qualified personnel, and the time demands on the qualified, schools need innovative ways of training trainers, disseminating useful practices and software and providing meaningful formative and summative evaluation. Effective programs would undoubtedly have some measure of success in dealing with these issues.

Recruiting Trainees

In order to recruit target students for computer training, a serious effort needs to be made. Many students will not volunteer on their own. Teachers can be enlisted in suggesting names of students as well as in approaching students to encourage them to participate. Friends and peers can encourage students to enroll, especially since the social role in learning can be very important for many of these students. Anticipate a dropout rate (a program we implemented as part of earlier work had a 25% dropout rate -- see Crist-Whitzel, et al., 1984). Therefore, when recruiting students add a waiting list of students for replacements during the first two weeks of class. Although it has been found by some that as many as three students can use one computer without suffering a loss in learning rate, we suggest that stationing only two students at a station will maximize the hands-on experience which

we feel is important for low-acheiving students. Thus the number of students recruited will be determined by hardware availability.

Scheduling Concerns. To minimize dropouts consider students' class load and the scheduling of the course. Friday and Monday after-school classes guarantee lower attendence. Our Tuesday-Wednesday-Thursday schedule seemed to cause minimal attendance problems. Since the course will become more difficult as it progresses, it is important to plan for the course to finish before students must prepare for final exams in their regular classes.

Course Length. While goals will vary among different schools, the curriculum described in the CREATE classes can be effectively taught in 40 to 50 hours of instruction. If additional time is available it would be desirable to add along the way more information about software applications and word processing or to include these applications and spend less time on BASIC, as we are considering doing in future classes.

Anticipate Language Problems. With Hispanic or other LES students, plan to have resources to assist in instruction. We found that a Spanish-speaking tutor who knew BASIC was able to provide invaluable help to such students. Translations of BASIC commands and statements to Spanish were also helpful. In spite of the language problems, with the special tutoring most of these students were able to learn programming if they attended regularly and applied themselves. One non-English speaking student did very well in the class. As mentioned earlier, tutoring or other bilingual assistance to Pacific Islanders (or other ESL students) could aid some students' programming skill development

Cooperative Learning Structures. Research has demonstrated that cooperative interaction in learning activities is effective in improving the academic performance of many ethnic minority students. Consider incorporating cooperative tasks in using the computer. For example, programming exercises or word

processing activities such as story building, or using data base systems for analyzing social science or business problems can be designed so that participation is required from all students (whether in pairs or larger groups). Role playing the steps involved in developing a guess-the-number game can emphasize problem solving and lead students to developing pseudo-code for writing the programs. Students can also work together in developing their game programs by sharing design and program-writing tasks as well as testing and debugging, thereby jointly enhancing their skills and shared pride in their creations.

Some Final Thoughts on Processes and Outcomes

It is gratifying to observe that students who would not qualify for computer classes in school learned and enjoyed computing as we noted in the example of our own case with the CREATE training program (Crist, et al., 1984). Clearly those students were motivated to learn and invested much commitment to finish their final programming pro jects. Until there is more research on the benefits of computing for improving cognitive skills, it will not be possible to claim that the programming experience truly improves these students' educational and employment futures. Nevertheless, programming clearly provides students with the opportunity to develop an awareness of computer capabilities, to conceptualize and design, to test and problem solve, and to receive concrete evidence of their success in learning a skill--opportunities that may not characterize their regular schooling experience.

Computing Focus

Whether or not BASIC language should be used for the programming course is an open question. Clearly the simplicity of the language, its wide availability, and its ready application to graphics programs without expense for software are big pluses. Graphics proved to be the strongest motivator for most of our

students. Initiating instruction in programming with graphics seems to be an approach worth trying. LOGO or some other turtle graphics would probably enhance students' sense of control over the computer. Again using our CREATE experience as an example, even our advanced high school trainers, as well as several trainees who happened to do some computer exploring with a TI-LOGO system we had, seemed to be captivated with LOGO. For schools with limited resources, the software expense for most versions of LOGO, or Karel or Pascal, as well as the need for disk drives might be prohibitive (however, we have found the VIC-20 Hes Turtle Graphics for $19.95). Even if schools have the hardware available there are still possible reasons for using BASIC for the target student group. For example dealing with a Pascal editor can be extremely frustrating for awhile, and there may not be the immediacy of feedback with some structured programming to test if the program will run. BASIC can, however, be taught in a structured way, and this approach to BASIC seems highly desirable for emphasizing logic and breaking down a problem into logical parts (e.g., see Luehrman & Peckham, 1983).

Computing should be integrated into the curriculum, as much as possible. We believe that, as microprocessor applications become more widespread the equity concerns regarding the potential cognitive and employment benefits of access to programming instruction will become largely replaced by concerns about access to computer applications such as word processing, data base management systems, and spreadsheet analyses. Such uses can be incorported into most subject matter areas and can be effective tools for enhancing problem solving skills. As Steve Jobs has maintained, the goal of more sophisticated software-hardware integration is to make the computer a tool or appliance like a pencil or toaster. Most people using computers will be using them as tools.

Program Models and Resources

We feel that Project CREATE designed one useful instructional model for motivating "high risk" learners, providing higher-level computer access, and having potential for implementation elsewhere. However, the next step may be to de-emphasize training everyone to program, focusing instead on guaranteeing that low-achieving and minority students be stimulated by active participation with computer software emphasizing active problem solving rather than passive drill and practice. The concept of basic skills should include the ability to access and manipulate computerized banks, information networks, and microprocesser-based controllers which will be encountered in many workplaces.

This evolving sense of priorities notwithstanding, the concept of student-managed computer programming instruction remains viable as one of the models for enhancing student access. It addresses the shortage of qualified teachers and facilities in public schools, and capitalizes on proven principles of instructional effectiveness. We conclude that further development of student computer trainers is highly worthwhile for expanding access to instruction to all students.

The peer training idea and its various potential representations, whether in classrooms or special programs within a school or in an extra-school situation such as the CREATE program described, seem worthy of additional trial and evaluation in different settings, at different levels of schooling, and with various age mixes.

Other models of providing computer access to target groups of students have also been developed and utilized and merit further study. As part of our Research on Equitable Access to Technology (REAT) project, we have compiled elsewhere a directory of such programs that exist in the Laboratory's region (see Crist-Whitzel, Sharp & Ellis, 1985) that can provide fruitful ideas for

educators and researchers. As an additional part of that project, we have also considered the implementation issues outlined in this review in addition to those revealed in our survey of regional programs and, as a response, have developed an implementation handbook that might be a guide to educators who wish to develop computer education programs for target students (Sharp & Crist-Whitzel, 1985). These companion project publications can serve as resources to those concerned with equity issues in educational technology.

References

Anderson, R. E., W. Welch, and L. Harris. Inequities in opportunities for computer literacy. The Computing Teacher, April 1984, 10-12.

Arias, B. Computer access for Hispanic students. Executive Summary: Bilingual Microcomputer Literacy Project, Stanford University, Stanford, California, 1984.

Aronson, E., N. Blaney, C. Stephan, J. Sikes, and M. Snapp. The Jigsaw Classroom, Beverly Hills: Sage Publications, 1978.

Assembly Office of Research, Computer literacy and Work Force Needs: Project Reseach Plans. Sacramento, 1982.

Baker, J.P. & Crist, J.L. Teacher expectancies: A review of the literature. In J.D. Elashoff & R.E. Snow, Pygmalion Reconsidered. Worthington, O.: Charles A. Jones, 1971.

Becker, H. School Uses of Microcomputers. Baltimore: Center for Social Organization of Schools, The Johns Hopkins University, Issue No.2, June 1983 (a).

Becker, H. How schools use micro-computers. Classroom Computer Learning, September 1983, 41-44 (b).

Berliner, D.C. Tempus educare. In P. Peterson & H.J. Walbert (Eds.), Research on teaching: Concepts, findings, and implications. Berkeley: McCutchan, 1979.

Bracey, G. Computers in education, what the research shows. Electronic Learning, November/December 1982, 51-54.

Brookover W. and L. Lezotte. Educational equity: a democratic principle at the crossroads. The Urban Review, 1981, 13 (2).

Brophy, J.E. Teacher behavior and student learning. Educational Leadership, 1979, 37, 33-38.

Campbell, P. Computers in education: a question of access. Paper presented at the Annual Meeting of American Education Research Association, Montreal, Quebec, 1983.

Cardenas, J. High technology and equal educational opportunity-part II. San Antonio: IDRA Newsletter, August 1983.

Castillo, Cathy. How kids score on computers. San Francisco Chronicle, January 10, 1984, 2.

Cohen, P., Kulik, J. and C.L. Kulik. Educational outcomes of tutoring: a meta-analysis of findings. AERJ, 1982, 19, (2), 237-248.

Connell, R. Schools climb aboard computer bandwagon. Los Angeles Times, Sunday, November 27, 1983.

Crist-Whitzel, J. Effective Teaching for Desegregated Settings: a Review and Application of Research. San Francisco: Far West Laboratory, Report #MESE805, 1980.

Crist-Whitzel, J., Dasho, S. & Beckum, L. Achieving equity: Student-led computer training. Paper presented at the Annual Meeting of the American Educational Research Association, New Orleans, 1984.

Crist-Whitzel, J., Sharp, P. & Ellis, N. A directory of programs fostering equitable access to computers. San Francisco: Far West Laboratory, 1985.

Dasho, S. and Beckum, L. Microcomputers and educational equity: the promise and peril. Paper presented at the Annual Meeting of the American Education Research Association, Montreal, Quebec, 1983.

Deutsch, M. The disadvantaged child and the learning process. In Deutsch, M. and Associates. The Disadvantaged child. New York: Basic Books, 1967.

Dusek, J.B. Do teachers bias children's learning? Review of Educational Research, 1975, 45, 661-684.

Education Daily. States move to review computer software for bias. Monday, January 23, 1984, 1-2.

Education Daily. Student race, not income, influences school computer policies. Monday, October 31, 1983, 1-2.

El News, Survey finds: micro's greatest educational impact is social. Electronic Learning, September 1983, 18-22.

Emmett, A. American education: the dead end of the 80s. Personal Computing, August 1983.

Euchner, C. 'Equal' access to computers in education could become major issue, experts warn. Education Week, March 2, 1983, 1.

Fisher, C., Marliave, R., & Filby, N. Improving teaching by increasing academic learning time. Educational Leadership, 1979, 37, 52-54.

Fisher, G. and L. Finkel. Hi-tech high school benefits few, majority suffers. InfoWorld, 17 (2), 17.

Fisher, G. Access to computers. The Computing Teacher, April 1984, 24-27.

Frank, C. Computers: perspectives and prospectives. Resources, New York City Public Schools, Division of Curriculum and Instruction, Winter/Spring, 1983, 7, (2).

Gibbons, J. Informational technology and its impact on American education. The Computing Teacher, January 1983, 18-29.

Good, T.L. & Brophy, J.E. Educational Psychology: A Realistic Approach. New York: Holt, Rinehart & Winston, 1977.

Good, T. and J. Brophy. Looking in Classrooms. New York: Harper & Row, 1973.

Gulardo, S. Computer education: a model program. Abstract of a paper presented at the Annual Meeting of American Education Research Association, Montreal, Quebec, April 1983.

Hamilton, M. Are girls smarter than boys? San Francisco Examiner, Sunday, February 12, 1984, Scene Arts, 1-2.

Hechinger, F. Experts warn schools on computer choices. San Mateo The Times, October 15, 1983, I-12

Hess, R. and I. Miura. Sex and class affect summer-camp enrollment. In Focus, April 25, 1983, 52-55.

Johnson, D.W. Student-student interaction: The neglected variable in education. Educational Researcher, 1981, 10, 5-10.

Johnson, D.W., Maruyama, G., Johnson, R., Nelson, D. & Skon, L. Effects of cooperative, competitive, and individualistic goal structures on achievement: A meta-analysis. Psychological Bulletin, 1981, 89, 47-62.

Karoff, P. Rich school, poor school. Teaching, Learning, Computing, January 1984, 50-56.

Kiesler, S., L. Sproull, and J. Eccles. Do little girls get equal opportunity in the compute world? Psychology Today, March 1983, 40-48.

Kulik, J., R. Bangert, and G. W. Williams. Effects of computer-based teaching on secondary school students. Journal of Educational Psychology, 1983, 75, 19-26.

Lesgold, A. and F. Reif. Computers in Education. Realizing the Potential. Chairmen's Report of a Research Conference, Pittsburgh, Pennsylvania, November 20-24, 1982. U.S. Department of Education, Office of Educational Research and Improvement, June 1983.

Luehrmann, A. and H. Peckham. Computer Literacy: A Hands-On Approach. New York: McGraw-Hill Book Company, 1983.

Mace, S. Governor calls for incentives for technical teachers. InfoWorld, 1983, 5, (17), 16.

Marrapodi, M. Boys and girls: equal access? Resources, New York City Public Schools, Division of Curriculum and Instruction, Winter/Spring, 1983, 7, (2).

Michaels, J.W. Classroom reward structures and academic performance. Review of Educational Research, 1977, 47, 87-98.

National Commission on Excellence in Education. A Nation at Risk: The Imperative for Educational Reform. Washington, D.C.: U. S. Department of Education, 1983.

NSBA. The biggest issue in computer education: computer equity. ComputerWise, September 1983, 4-5.

Norman, C. A Teacher Survey NEA Report: Computers in the Classroom. National Education Association, 1983.

Palardy, J.M. What teachers believe, what children achieve. Elementary School Journal, 1969, 69, 370-374.

Podemski, R., S. Husk, and A. Jones. Micros and the disadvantaged. Electronic Learning, March 1983, 20-22.

Powell, M. New evidence for old truths. Educational Leadership, 1979, 37, 49-51.

Puetz, W. Social implications of pushing for computer literacy. InfoWorld, January 1984, 41-45.

Ramirez, M., III & Castaneda, A. Cultural democracy, bicognitive development, and education. New York: Academic Press, 1974.

Resnick, H. Creative teachers make computers part of the job. Learning, March 1984, 32-38.

Rist, R.C. Student social class and teacher expectation: The self-fulfilling prophecy in ghetto education. Harvard Educational Review, 1970, 40, 411-451.

Ryba, K. and J. Chapman. Toward improving learning strategies and personal adjustment with computers. The Computing Teacher, August 1983, 48-53.

Saracho, O. The effects of a computer-assisted instruction program on basic skills achievement and attitudes toward instruction of Spanish-speaking migrant children. AERJ, 1982, 19 (2), 201-219.

Sharan, S. Cooperative learning in small groups: Recent methods and effects on achievement, attitudes, and ethnic relations. Review of Educational Research, 1980, 50, 241-271.

Sharp. P. & Crist-Whitzel, J. Computers for all children: A handbook for program design. San Francisco: Far West Laboratory, 1985.

Siegel, L. Researchers challenge portrait of a high-tech future. InfoWorld, 5 (20), 31.

Slavin, R.E. Alternative student evaluation structures in desegregated classrooms. Paper presented at the Annual Meeting of the AERA, Boston, 1980 (a).

Slavin, R.E. Cooperative learning. Review of Educational Research, 1980, 50, 315-342(b).

Slavin, R.E. How student learning teams can integrate the desegregated classroom. In M. Weinberg & G. Martin (Eds.), School Desegregation in America: Experiences and Explorations. Evanston: Center for Equal Education, 1977, 56-58(b).

Slavin, R. Student teams and comparison among equals: effects on academic performance and student attitudes. Journal of Educational Psychology, 1978, 70, 532-538.

Stallings, J. Allocated academic learning time revisited, or beyond time on task. Educational Researcher, 1980, 9, 11-16.

Stevens, G. Computer tutors. San Francisco Examiner and Chronicle, Sunday, September 19, 1982.

TERC, 1983, 6 (1), 2-6.

The Stanford Educator, School of Education News, Winter 1984.

Time, May 3, 1982, 50-56.

Van Nuys, U. Why is the world of computers dominated by males? InfoWorld, 5 (35), 8-10.

Witkin, H.A., Moore, C.A., Goodenough, D.R., & Cox, P.W. Field-dependent and field-independent cognitive styles and their educational implications. Review of Educational Research, 1977, 47, 1-64.